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ABSTRACT

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Factor Structure of the Vocational Interest Models of Roe and Holland

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Analyses of interscale relations in 235 college students for the Vocational Preference Inventory and Vocational Interest Inventory, based on interest models of Holland and Roe respectively, suggest that the two-dimensional, circular configuration of occupations or personality types may be an oversimplification which impedes the understanding of the structure of vocational interests. For both interest models four orthogonal dimensions seem necessary to capture interindividual variability: Social vs. Technical, Organizational vs. Outdoor, Science vs. Business, and Artistic.

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It is not unusual to find researchers working with Holland's theory or his Vocational Preference Inventory (VPI) to mention the likeness between his hexagonal model and the circular ordering of occupations proposed by Roe (1956). Indeed, Holland says Roe's ordering is "similar if not identical" to his model (1973, p. 81). Thus, corresponding to Holland's well-known RIASEC (Realistic, Intellectual, Artistic, Social, Enterprising, Conventional) would be Roe's Technical, Outdoor, Science, General Cultural, Arts & Entertainment, Service, Business Contact, and Organization. Both orderings are intended to place more related groups next to one another.

Aside from the "Ramak questionnaire in use in Israel (Meir and Barak, 1974), the only instrument known to measure Roe's eight activity foci is the Vocational Interest Inventory or VII (Lunneborg, 1975). This test has been in use since 1970 with high school (HS) students who take the Washington Pre-College Test Battery. The VII is based on Roe's two-way classification system which assigns every occupation both to a level, based on the responsibility and education required, and to a group representing the focus of activity in the occupation. There are six levels with Level 1 being the top. Roe's system is avocational as well as vocational, i.e., while it refers to interests connected with occupations, it could be used with reference to leisure-time activities as well.

The eight groups as they are described in the VII are:

(A) technology (TEC): concerned with production, maintenance, and transportation of commodities and utilities; examples include architecture, data processing, drafting, electronics, engineering, factory lead, machine operator, mechanic, pilot

(B) outdoor (OUT): agriculture, fishery, forestry, mining; examples include conservationist, farm owner/manager, geologist, sailor, surveyor

(C) science (SCI): research in all social and natural sciences; examples include college anthropology teacher, dentist, doctor, home economist, lab technician, mathematician, nurse, physical therapist, veterinarian, weather observer

(D) general cultural (CUL): occupation in education, journalism, law, linguistics; includes all elementary and high school teachers; college teachers in humanities

(E) arts and entertainment (ART): uses special skills in creative arts, entertainment, or sports; includes commercial artist, designer, interior decorator, musician, photographer, professional athlete, TV or stage acting

(F) service (SER): attending to the needs and welfare of others through guidance, domestic, personal and protective services, examples include barber/beautician, clinical psychology, counseling, firefighting, ministry, police, social work, waiter/waitress

(G) business contact (BUS): face-to-face personal persuasion to sell commodities, services, investments; examples include auto sales, insurance, lobbying, public relations, real estate

(H) organization (ORG): managerial, ownership, or white collar job in business, industry, or government, examples include accounting, administration, business manager, buyer, clerk, retail sales, secretary, teller

The VII consists of 112 forced-choice items divided into two sets of 56 items each, an Occupations section and an Activities section. Each item in Occupations consists of two occupations and students are to indicate in which of the two they have more interest. Each pair of occupations is matched for level and drawn from two different Roe groups. Each group is paired twice with each of the other groups to produce the 56 items.

The Activities Section again matches each of the eight groups twice with each other group and was written to tap behaviors associated with

the eight interest areas. An example of ART vs. CUL: I would rather visit a (a) museum of modern art (b) new community library.

Each VII scale thus consists of 28 items, 14 from each of the two sections of the test. Items are given unit weight so that scores on each scale can range from 0 to 28. The VII requires a minimal amount of administrator effort and takes a maximum of 25 minutes testing time. The VII was constructed to avoid items showing large sex differences and uses norms based on all HS juniors (not separate sex norms).

There is ample evidence that the circular ordering of personality types postulated by Holland (1973) is reflected in the VPI. The evidence is of two kinds: application of an innovative spatial configuration analysis (Cole and Cole, 1970) and measurement in factor space of the distance between scale types (Wakefield and Doughtie, 1973). At the same time there is also evidence that more than two dimensions underlie Holland's hexagon (Cole, Whitney, and Holland, 1971; Edwards and Whitney, 1972; Wakefield and Doughtie, 1973). Taken together these results suggest that the planar, two-dimensional, circular arrangement, while a reasonable first approximation to the structuring of occupational interests, is an oversimplification. This oversimplification may lead to difficulties in the counseling use of the circular model. For example, Cole, Whitney, and Holland (1971) express concern at the placement of Mathematician close to Construction and Farming (the Realistic centroid) as a function of the averaging of high scores on the adjacent Intellectual and Conventional scales. Clinical Psychology in the same analysis appears in close contiguity to Art and Music (the Artistic centroid) presumably because of an averaging of high Intellectual and Social interests.

If the planar representation is marginal, additional light should be cast by a comparative analysis of the VII and VPI in the same sample. Perhaps the VPI data fit as well as they do on the plane because of the small number of scales (6) and because one measurement degree of freedom seems to be given over to the assessment of what Cole, Whitney, and Holland refer to as "overall checking rate." The VII, with two additional scales and an ipsative, forced-choice format, should be free of these restrictions.

Method

Subjects. Student volunteers who received extra credit in Introductory Psychology were administered the VPI and VII at the University's Educational Assessment Center. Ss were tested in small groups and the order of the tests was counterbalanced to control for order effects. For their participation Ss also received their VPI profile the following week with self-interpretive materials. The total N was 235, 136 females, 99 males.

Procedures. Three sets of analyses were conducted. Separately for the VPI and VII data, configural analyses based on the Coles' (1970) procedure evaluated the planar fit and circular hypothesis. Similarly, the factor distance measures of Wakefield and Doughtie (1973) were computed as an assessment of circularity. Finally, varimax rotations of the large, significant components were evaluated. Varimax rotations of components obtained in a joint factoring of VPI and VII scores were also computed.

Results

VPI. Table 1 presents the principal components analysis of VPI scores. There were three components with eigenvalues in excess of unity accounting for 77.5% of variance. Projection of six VPI scales on to the best-fitting plane (Cole and Cole, 1970) for these data produced the configuration in Figure 1. The planar fit accounted for 67% of the variance comparing favorably with 64% obtained with males alone (Cole and Hanson, 1971) and with 60% for females (Cole, 1973).

The interscale distances in Table 2 were obtained by applying Wakefield and Doughtie's (1973) technique to the three-dimensional space defined by the varimax factors of Table 3. The postulated relationships between these distances were even stronger here than those reported by Wakefield and Doughtie. All adjacent scale distances were smaller than all intermediate scale distances, and all but one of the intermediate scale distances were smaller than the opposite distances. The CI distance was the exception being larger than either RS or AC. The three varimax factors for the VPI reported in Table 3 and depicted

Table 1

Principal Components Analysis of VPI Scores

Factors	1	2	3	4	5	6
Eigenvalues	1.96	1.44	1.25	.63	.44	.28
Percent variance	32.7	24.0	20.8	10.5	7.3	4.7
VPI Scales	Loadings					
Real	.53	.42	-.59	.10	-.43	.07
Int	.25	.82	-.24	-.17	.41	.06
Art	.37	.46	.62	.50	-.02	-.16
Soc	.54	.12	.61	-.54	-.18	.05
Ent	.77	-.46	.05	.22	.17	.34
Conv	.78	-.39	-.29	-.10	.12	-.36

Note. Abbreviations throughout tables: Real = Realistic; Int = Intellectual; Art = Artistic; Soc = Social; Ent = Enterprising; Conv = Conventional; Tec = Technology; Out = Outdoor; Sci = Science; Cul = General Cultural; Art = Arts & Entertainment; Ser = Service, Bus = Business Contact; Org = Organization.

Table 2

Distances between VPI Scales

	Adjacent Scales		Intermediate Scales		Opposite Scales	
R	CR	.90	ER	1.12	RS	1.24
	RI	.60	RA	1.22		
I	RI	.60	CI	1.32	IE	1.42
	IA	.94	IS	1.14		
A	IA	.94	RA	1.22	AC	1.31
	AS	.38	AE	1.16		
S	AS	.38	IS	1.14	SR	1.24
	SE	.84	SC	1.06		
E	SE	.84	AE	1.16	EI	1.42
	EC	.35	ER	1.12		
C	EC	.35	SC	1.06	CA	1.31
	CR	.90	CI	1.32		

Note. Abbreviations: R = Realistic; I = Intellectual; A = Artistic, S = Social; E = Enterprising; C = Conventional.

Table 3

VPI Factor Loadings for 235 College Students

VPI Scales	Varimax Factors		
	Realistic-Intellectual II	Artistic-Social III	Enterprising-Conventional I
Real	.83	-.09	.31
Int	.84	.21	-.20
Art	.15	.84	-.07
Soc	-.04	.78	.25
Ent	-.09	.21	.87
Conv	.16	-.03	.90

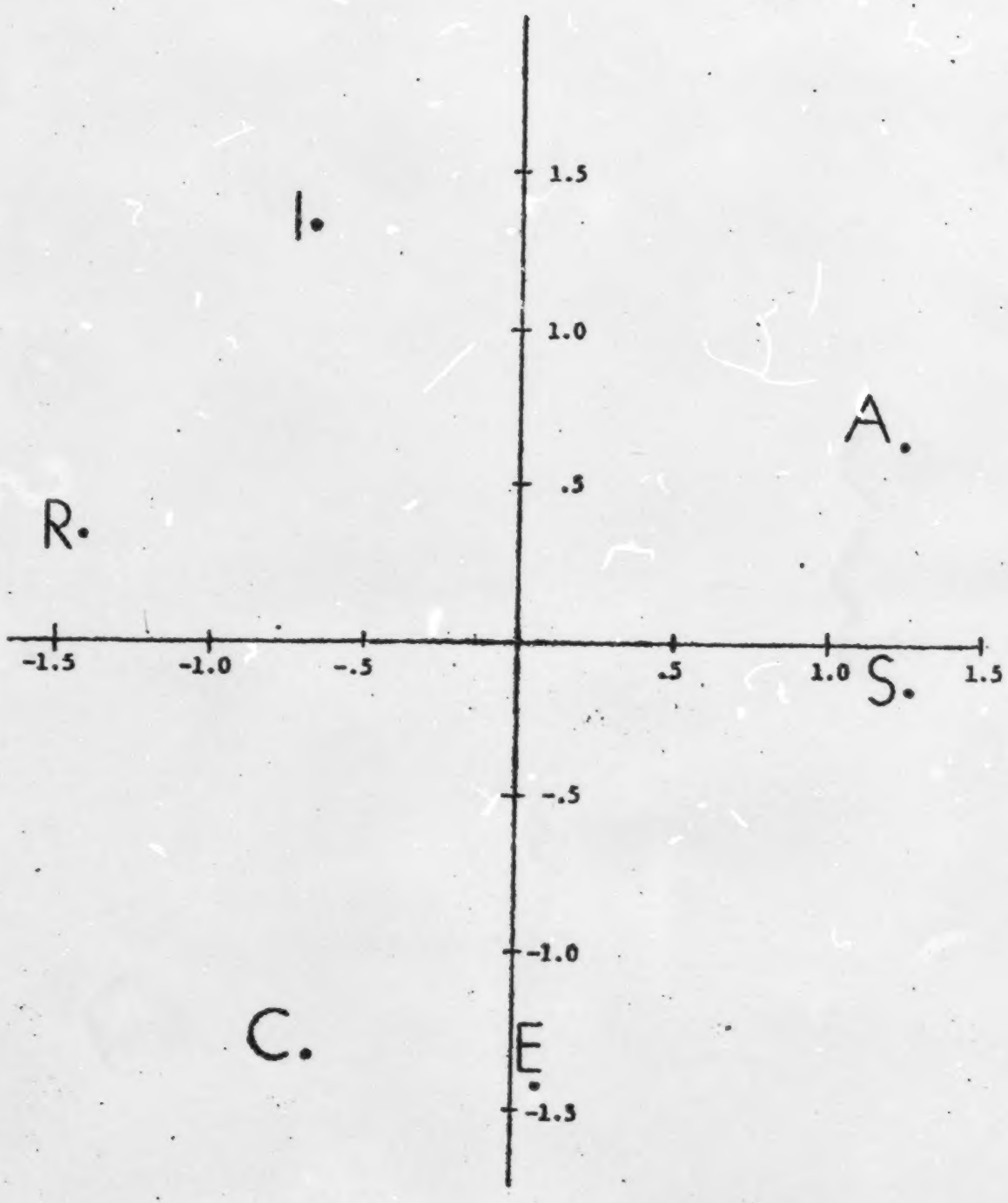

Figure 1. Spatial configuration based on VPI scores.

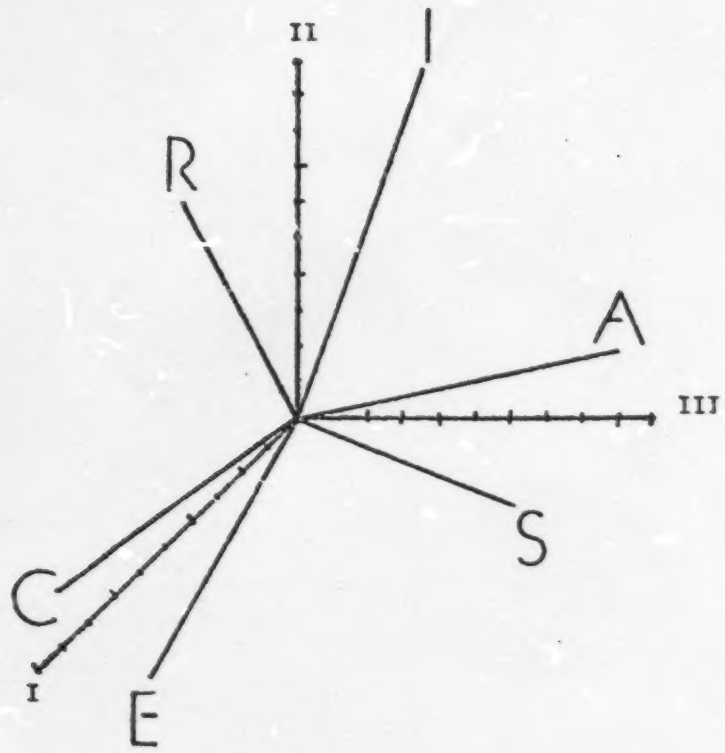

Figure 2. Projection of VPI scale in three-dimensional varimax factor space.

three-dimensionally in Figure 2 support the notion that the following adjacent scales are linked: R and I, A and S, E and C. These three pairings are consistent with the interscale distances of Table 2 and positionings of the scales in Figure 1. (In visualizing Figures 2 and 4, the graduated lines correspond to factors; the solid lines denote positions of scales that extend toward the viewer; the dashed lines are scale positions that stretch backward in three-dimensional space.)

VII. Table 4 presents the principal components analysis of VII scores. Again, there were three components with eigenvalues in excess of unity. Inasmuch as the fourth eigenvalue was very close to 1, however, the first four components were used in the varimax solution. These four accounted for 75.9% of variance. Projection of the eight VII scales on to the best-fitting plane produced Figure 3 which follows the circular ordering of Figure 1 in that Tec and Sci are in RI quadrant, Art in the A quadrant, etc. This planar fit, however, accounted for only 49% of the variance. Also the Out and Cul scales did not appear in the positions predicted by Roe (1956), i.e., Out was not between Tec and Sci, nor Cul between Sci and Art.

Table 5 presents the interscale distances computed within the four-dimensional space defined by the varimax factors of Table 6. In constructing Table 5 the VII scales are ordered as they appear circularly in Figure 3. The striking aspect to Table 5 is that when the VII is constrained to two-dimensions as in Figure 3, these interscale distances are severely misrepresented. In four-dimensional space Out is closer to Tec (.87) than it is to either Sci (1.31) or Art (1.28) yet in Figure 3 it appears farther from Tec than from these latter two scales. Similarly, in four-dimensional space Art is closest to Cul (1.27), yet when the scales are forced into two-dimensional space Cul is not adjacent to Art.

The four varimax factors of Table 6 highlight the shortcomings of the planar representation of Figure 3. Indeed, Figure 3 appears to be close to the plane which would be defined by the first two varimax factors--Org vs. Out and Ser vs. Tec. The Bus vs. Sci distinction and the independent contribution of Art are lost in two-dimensional space.

The factor loadings on Factors I, II, and III were used to prepare the three-dimensional plot given in Figure 4. This figure illustrates the need for conceptualizing the dimensionality of the VII and Roe's classification system beyond the boundaries of a plane. As an example, the distinction between Bus and Org (Enterprising and Conventional) is a real one, but it is not one that is captured in the two dimensions of Figures 1 and 3. From Table 6 and Figure 4 it can be seen that while Org is nearly the opposite of Out, Bus is not. Rather, Bus is drawn away from Org by its high loading on Factor III. As another example, in Holland's model the Realistic type combines the Tec and Out occupations of Roe's system. Yet, when they are considered separately, they help to define two orthogonal dimensions, Tec for II and Out for I.

VPI and VII. Table 7 displays the correlations among the six VPI and eight VII scales. The highest VPI-VII correlations were as follows: Real with Tec, Int with Sci, Art with Art, Soc with Ser, Ent with Bus, and Conv with Org. All these are in accord with the theoretical agreement between Roe's and Holland's schemes. As for the "additional" VII scales, Out correlated most highly with Real and Int, while Cul correlated most highly with Soc and Art. Table 8 gives the varimax factor loadings for the fourteen scales. The five principal components which were rotated accounted for 75.4% of the variance and were all associated with eigenvalues in excess of unity. (The sixth eigenvalue was .83.)

The four VII factors were well reflected in the results of Table 8. The fifth factor, termed Realistic, would seem to be a combination of RI from the VPI as well as a "popularity" factor, taking into account the all positive loadings for the VPI plus the high loading for VII Out. Outdoor interest was the most popular area in the VII standardization sample.

Discussion

These results clearly establish that more than two dimensions are needed to account for the structure of vocational interests as conceptualized by Holland and Roe. At least three and as many as five factors may be necessary using instruments such as the VPI and VII. Is one of these numbers of factors "better" than another number? Can the factors be interpreted meaningfully? Answers are suggested by comparing the present findings with those of Edwards and Whitney (1972).

Table 4

Principal Components Analysis of VII Scores

Factors	1	2	3	4	5	6	7[a]
Eigenvalues	2.28	1.66	1.16	.97	.77	.59	.55
Percent variance	28.5	20.8	14.5	12.1	9.6	7.4	6.9
VII Scales	Loadings						
Tec	-.52	.60	.05	.29	.02	.50	.17
Out	-.72	-.22	.23	.44	.02	-.32	-.29
Sci	-.54	.10	-.60	-.51	-.13	-.18	.15
Cul	.54	-.46	-.12	.27	-.62	.10	.12
Art	-.07	-.46	.67	-.54	.05	.20	.00
Ser	.37	-.55	-.41	.18	.59	.13	.05
Bus	.59	.50	.33	.07	.14	-.36	.36
Org	.64	.52	-.11	-.16	-.02	.08	-.52

[a]An eighth eigenvalue of .01 and associated vector omitted.

Table 5

Distances between VII Scales

	Adjacent Scales		Intermediate Scales				Opposite Scales	
			Two-Away		Three-Away			
Tec	Org-Tec	1.26	Bus-Tec	1.17	Cul-Tec	1.51	Tec-Ser	1.53
	Tec-Sci	1.15	Tec-Out	.87	Tec-Art	1.55		
Sci	Tec-Sci	1.15	Org-Sci	1.39	Bus-Sci	1.63	Sci-Cul	1.53
	Sci-Out	1.31	Sci-Art	1.47	Sci-Ser	1.33		
Out	Sci-Out	1.31	Tec-Out	.87	Org-Out	1.69	Out-Bus	1.55
	Out-Art	1.28	Out-Ser	1.33	Out-Cul	1.34		
Art	Out-Art	1.28	Sci-Art	1.47	Tec-Art	1.55	Art-Org	1.49
	Art-Ser	1.37	Art-Cul	1.27	Art-Bus	1.36		
Ser	Art-Ser	1.37	Out-Ser	1.33	Sci-Ser	1.33	Ser-Tec	1.53
	Ser-Cul	.36	Ser-Bus	1.31	Ser-Org	1.19		
Cul	Ser-Cul	.36	Art-Cul	1.27	Out-Cul	1.34	Cul-Sci	1.53
	Cul-Bus	1.09	Cul-Org	1.08	Cul-Tec	1.51		
Bus	Cul-Bus	1.09	Ser-Bus	1.31	Art-Bus	1.36	Bus-Out	1.55
	Bus-Org	.50	Bus-Tec	1.17	Bus-Sci	1.63		
Org	Bus-Org	.50	Cul-Org	1.08	Ser-Org	1.19	Org-Art	1.49
	Org-Tec	1.26	Org-Sci	1.39	Org-Out	1.69		

Table 6

VII Factor Loadings for 235 College Students

VII Scales	Varimax Factors			
	Service vs. Technical	Organizational vs. Outdoor	Business vs. Science	Artistic
	II	I	III	IV
Tec	-.70	-.21	.02	-.43
Out	-.25	-.86	.09	-.07
Sci	-.21	-.04	-.94	-.09
Cul	.71	.05	.28	-.04
Art	-.04	-.14	.07	.96
Ser	.78	-.03	-.05	-.12
Bus	-.17	.61	.56	-.05
Org	-.02	.82	.14	-.17

Table 7

Correlations among VPI and VII Scales (N = 235)

(Decimal points omitted)

	Real	Int	Art	Soc	Ent	Conv	Tec	Out	Sci	Cul	Art	Ser	Bus	Org
Real		43	07	00	15	33	40	30	12	-21	-14	-28	-17	-10
Int			22	10	-15	-01	10	26	53	-05	-04	-23	-36	-35
Art				36	15	-06	-32	13	-25	27	60	02	-16	-26
Soc					25	21	-36	-18	-17	36	00	53	-10	03
Ent						64	-11	-35	-40	11	-04	-08	55	46
Conv							05	-33	-11	03	-26	-13	28	57
Tec								18	10	-43	-25	-40	-09	-12
Out									03	-27	00	-21	-41	-54
Sci										-33	-17	-19	-41	-23
Cul											-06	21	-02	03
Art												-08	-15	-26
Ser													-12	-06
Bus														37
Org														

Table 8

VII and VPI Factor Loadings for 235 College Students

Scales	Realistic	Science vs. Business	Artistic	Social vs. Technical	Organizational vs. Outdoor
	IV	V	III	II	I
Real	.85	.21	-.02	-.13	.10
Int	.41	.76	.17	.02	-.11
Art	.19	-.00	.85	.32	-.06
Soc	.16	.06	.10	.85	.14
Ent	.24	-.28	.18	.12	.79
Conv	.34	.06	-.12	.09	.81
Tec	.49	-.05	-.35	-.55	-.10
Out	.52	-.08	.08	-.19	-.65
Sci	-.10	.88	-.22	-.23	-.16
Cul	-.15	-.09	.14	.63	.10
Art	-.20	-.06	.86	-.10	-.16
Ser	-.23	-.18	-.24	.76	-.21
Bus	-.18	-.47	-.04	-.19	.59
Org	-.21	-.13	-.24	-.01	.77

Note. Loadings $\geq |.4|$ underlined.

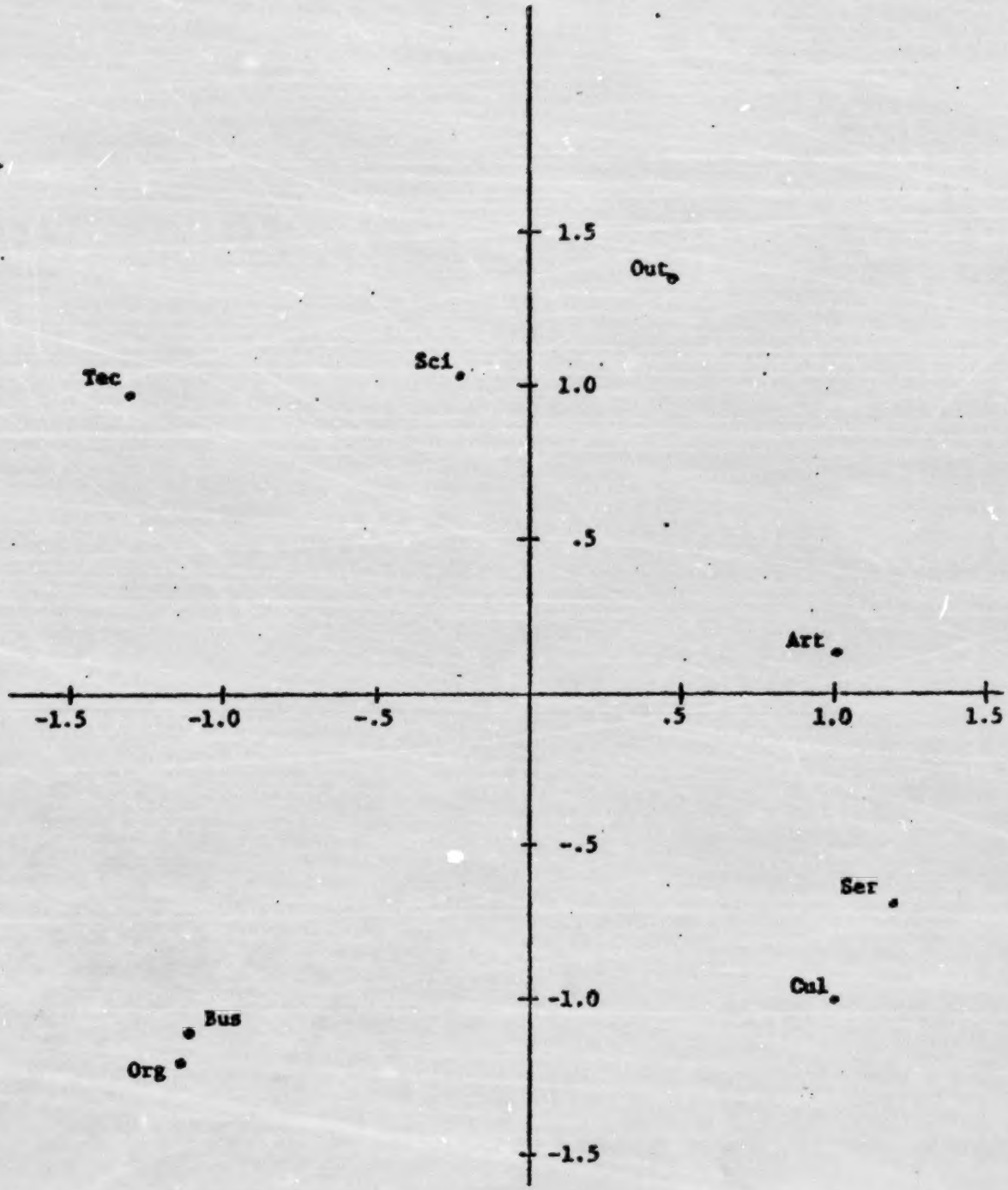

Figure 3. Spatial configuration based on VII scores.

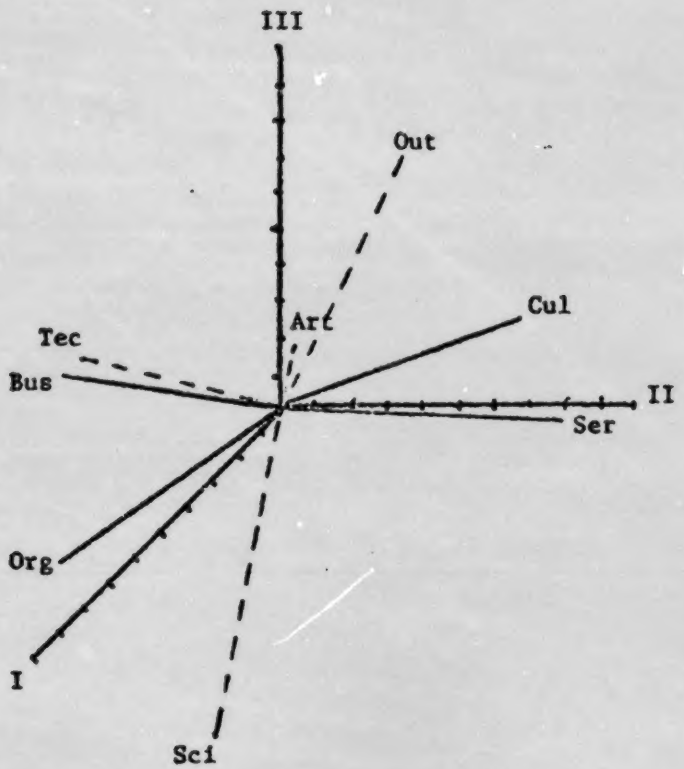

Figure 4. Projection of VII scales in the three-dimensional space of varimax factors I, II, and III. Dashed lines indicate that the largest loading is negative--Out on I, Tec on II, and Sci on III.

Working with Holland's Self-Directed Search (SDS), another instrument based on the RIASEC types, Edwards and Whitney consistently found four factors: Realistic-Investigative defined a first factor, Social-Enterprising a second, while Conventional and Artistic were separate third and fourth factors. Their results resemble the factorings of the VII alone and VPI and VII taken together. In both of these analyses (Tables 6 and 8) the following four factors were isolated: Social vs. Technical, Organizational vs. Outdoor, Science vs. Business, and Artistic. As anticipated, the ipsative nature of the VII plus the separating out of an Outdoor scale, sharpened the distinctions which Edwards and Whitney found blurred: R and I were separated as were S and E by the emergence of the two bipolar factors, Social vs. Technical and Science vs. Business.

What of the fifth VPI-VII factor, the so-called Realistic factor? It is not like the Realistic-Investigative factor found by Edwards and Whitney (1972) which typically had negative loadings by scales other than R and I. It <u>is</u> like the first factor found by Cole, Whitney, and Holland (1971) which had high positive loadings by all six VPI scales. Finding all scales loading positively was interpreted by them as a response set factor reflecting overall checking rate. A similar interpretation of this fifth factor may be found in Wakefield et al. (1975) where a canonical variate in the VPI linked the Realistic type to the Acquiescent response set. Interestingly, when Acquiescence is controlled by the forced-choice format of the VII, this factor disappears.

Given that the results of Edwards and Whitney (1972) and the present study concur in that at least four factors were required to account for the variability in vocational interests in the RIASEC and Roe systems, what are the implications of describing occupational groups in only two dimensions? If two dimensions account for less than half the variability (which is the case for many instruments to which the spatial configuration analysis has been applied), and four dimensions account for 75-80% of variance, restricting descriptions to two dimensions represents a significant loss of information. With reference to the two examples cited earlier, it would be more accurate to describe the Mathematician as Intellectual and Conventional rather than Realistic. Similarly, it would

be more accurate to say that Clinical Psychologist was Intellectual and Social, not Artistic. To do so, however, requires going beyond two dimensions.

The next step in conceptualizing vocational interests in four-dimensional space will be to assign to occupations factor scores based on the four factors in the VII. Only then can the utility of this factor structure for test interpretation and counseling be known.

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